

CLAIMS

We claim:

1. In an audio encoder, a computer-implemented method of audio encoding according to a multi-pass variable bitrate control strategy, the method comprising:
 - 5 in a first pass, encoding a sequence of audio data; and
 - in a second pass, encoding the sequence of audio data in view of a target quality level to produce variable bitrate output, wherein the target quality level is based at least in part upon statistics from the encoding in the first pass.
 - 10 2. The method of claim 1 further comprising computing a checkpoint, wherein the encoding in the second pass includes adjusting the target quality level based at least in part upon results of the encoding in the second pass as of the checkpoint.
 - 15 3. The method of claim 2 wherein the checkpoint is set at a percentage of progress towards a target total bit count for the sequence.
 - 20 4. The method of claim 2 further comprising, at the checkpoint, computing a subsequent checkpoint, wherein the encoding in the second pass includes adjusting the target quality level based at least in part upon results of the encoding in the second pass as of the subsequent checkpoint.

- 5 5. The method of claim 1 wherein a peak bitrate constraint further affects the encoding in the second pass.
6. The method of claim 1 wherein the target quality level is based at least in part
5 upon a target total bit count.
7. The method of claim 1 further comprising:
storing auxiliary information from the encoding in the first pass; and
using the auxiliary information in the encoding in the second pass to increase
10 speed of the encoding in the second pass.
8. The method of claim 7 wherein the auxiliary information is selected from the group consisting of mask values, tile configurations, and channel transforms.
- 15 9. The method of claim 1 wherein the encoding in the first pass includes encoding at least part of the audio data at plural different quality levels.
10. The method of claim 1 wherein the statistics include quantization step size, bits, and quality level at each of plural quality levels for each of plural chunks of the
20 audio data.

11. The method of claim 1 further comprising, in the second pass, adjusting the target quality level based upon intermediate results of the encoding in the second pass.
 12. The method of claim 1 wherein the audio data is partitioned into variable-size chunks for the encoding in the first and second passes.
 13. The method of claim 12 wherein the variable-size chunks selected from the group consisting of tiles, frames, and blocks.
- 10 14. The method of claim 1 wherein the target quality level is for the sequence.
- 15 15. The method of claim 1 wherein the audio data in the second pass and the audio data in the first pass are for the same sequence but are non-identical.
- 15 16. The method of claim 1 further comprising:
 computing a first signature for the audio data in the first pass;
 computing a second signature for the audio data in the second pass;
 comparing the first and second signatures, wherein the encoding in the second pass ends if the first and second signatures indicate a discrepancy between the audio data in the first pass and the audio data in the second pass.
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17. A computer-readable medium storing computer-executable instructions for causing a computer system programmed thereby to perform the method of claim 1.
18. In a computer system, a computer-implemented method of media encoding
 - 5 according to a multi-pass variable bitrate control strategy, the method comprising:
 - in a first pass, encoding media data partitioned into variable-size chunks for the encoding;
 - processing results of the encoding in the first pass to determine one or more control parameters for the media data; and
 - 10 in a second pass, encoding the media data according to the one or more control parameters in view of a goal of uniform quality at variable bitrate.
19. The method of claim 18 wherein the media data are audio data.
- 15 20. The method of claim 18 wherein the variable-size chunks are tiles.
21. The method of claim 18 wherein the variable-size chunks are frames.
22. The method of claim 18 wherein the variable-size chunks are blocks.

23. The method of claim 18 wherein the processing includes computing a checkpoint, and wherein the encoding in the second pass includes checking results of the encoding in the second pass at the checkpoint.

5 24. The method of claim 23 further comprising, at the checkpoint in the second pass, adjusting the one or more control parameters and computing a subsequent checkpoint.

10 25. The method of claim 18 wherein a peak bitrate constraint affects quality and bitrate in the second pass.

15 26. The method of claim 18 wherein a target total bit count constrains the one or more control parameters in view of complexity of the media data.

20 27. The method of claim 18 further comprising using auxiliary information from the encoding in the first pass in the encoding in the second pass to increase speed of the encoding in the second pass.

25 28. The method of claim 18 wherein the encoding in the first pass includes encoding at least part of the media data at plural different quality settings.

29. The method of claim 18 wherein the encoding in the first pass includes computing triplets for the variable-size chunks, wherein each of the triplets includes a value for each of quantization step size, bits, and quality setting.

5 30. The method of claim 18 wherein the one or more control parameters include a target quality setting.

10 31. The method of claim 18 further comprising repeating the processing during the encoding in the second pass such that the one or more control parameters influence and are influenced by the encoding in the second pass.

15 32. The method of claim 18 further comprising comparing signatures for the first and second passes, wherein the encoding in the second pass ends if the signatures indicate a discrepancy in the media data between the first and second passes.

33. A computer-readable medium storing computer-executable instructions for causing the computer system to perform the method of claim 18.

20 34. In a computer system, a computer-implemented method of audio encoding according to a multi-pass variable bitrate control strategy, the method comprising:

- in a first pass, encoding audio data, including computing triplets for plural chunks of the audio data, wherein each of the triplets includes a value for each of quantization step size, bits, and quality setting; and
- in a second pass, encoding audio data to produce variable bitrate output at a
- 5 target quality level.
35. The method of claim 34 wherein the encoding in the first pass includes computing three or more triplets for at least one of the plural chunks.
- 10 36. The method of claim 34 wherein the encoding in the first pass includes computing triplets for a given one of the plural chunks until the computed triplets describe a useful range of a step-rate-distortion pattern for the given chunk.
37. A computer-readable medium storing computer-executable instructions for
- 15 causing the computer system to perform the method of claim 34.
38. In an audio encoder, a computer-implemented method comprising:
- determining a first quality level associated with a first quantization level;
- determining a second quality level associated with a second quantization level;
- 20 from the first and second quantization levels and the first and second quality levels, computing a target quantization level corresponding to a target quality level by

interpolation according to a linear relation between logarithm of quantization level and logarithm of quality level; and

using the target quantization level in a control strategy for audio encoding.

- 5 39. In an audio encoder, a computer-implemented method comprising:
 - determining a first bit count associated with a first quantization level;
 - determining a second bit count associated with a second quantization level;
 - from the first and second bit counts and the first and second quantization levels,
 - computing a target bit count corresponding to a target quantization level according to a
- 10 linear relation between logarithm of bit count and quantization level; and
- using the target bit count in a control strategy for audio encoding.

40. In an audio encoder, a computer-implemented method comprising:
 - determining a first quality level associated with a first quantization level;
 - 15 determining a second quality level associated with a second quantization level;
 - from the first and second quantization levels and the first and second quality
 - levels, computing a target quantization level corresponding to a target quality level
 - according to a function relating quantization level and quality level;
 - determining a first bit count associated with the first quantization level;
 - 20 determining a second bit count associated with the second quantization level;

from the first and second bit counts and the first and second quantization levels, computing a target bit count corresponding to the target quantization level according to a function relating bit count and quantization level; and
using the target bit count in a control strategy for audio encoding.

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41. In a computer system, a computer-implemented method of media encoding according to a multi-pass control strategy, the method comprising:

in a first pass, encoding media data;
storing auxiliary information from the encoding in the first pass; and
10 in a second pass, encoding the media data, including using the stored auxiliary information to increase speed of the encoding in the second pass.

42. The method of claim 41 wherein the media data are audio data.

15 43. The method of claim 41 wherein the auxiliary information comprises mask values.

44. The method of claim 41 wherein the auxiliary information comprises tile configurations.

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45. The method of claim 41 wherein the auxiliary information comprises channel transforms.

46. The method of claim 41 wherein the encoding in the second pass produces variable bitrate output around a target quality.

47. A computer-readable medium storing computer-executable instructions for
5 causing the computer system to perform the method of claim 41.

48. In a computer system, a computer-implemented method comprising:
in a first pass, computing a first pass signature for each of one or more portions
of media data and encoding the one or more portions; and
10 in a second pass,
computing a second pass signature for a given portion of the one or more
portions;
comparing the second pass signature with the first pass signature for the
given portion;
15 if the first pass signature matches the second pass signature, encoding the
given portion;
otherwise, performing one or more alternative actions.

49. The method of claim 48 wherein the media data are audio data.
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50. The method of claim 48 wherein the portions are chunks.

51. The method of claim 48 wherein the first pass and second pass signatures are based at least in part upon an XOR of input bytes of media data.

52. The method of claim 48 wherein the first and second passes are part of a
5 multi-pass variable bitrate control strategy.

53. The method of claim 48 wherein the one or more alternative actions include stopping the second pass.

10 54. The method of claim 48 wherein the one or more alternative actions include notifying the user.

55. The method of claim 48 wherein the one or more alternative actions include encoding the given portion using alternative encoding techniques.

15 56. A computer-readable medium storing computer-executable instructions for causing the computer system to perform the method of claim 48.

57. In an audio encoder, a computer-implemented method of audio encoding
20 according to a multi-pass variable bitrate control strategy, the method comprising:
in a first pass, encoding a sequence of audio data; and

in a second pass, encoding the sequence of audio data in view of a goal of uniform quality at variable bitrate, wherein a peak bitrate constraint affects quality and bitrate in the second pass.

5 58. The method of claim 57 wherein the audio encoder models a decoder buffer to test the peak bitrate constraint.

10 59. The method of claim 58 wherein the audio encoder reduces a target quality to avoid underflow in the decoder buffer.

15 60. A computer-readable medium storing computer-executable instructions for causing a computer system programmed thereby to perform the method of claim 57.

20 61. In a media encoder, a computer-implemented method of media encoding, the method comprising:

 selectively enabling or disabling a peak bitrate constraint for a sequence of media data;

 in a first pass, encoding the sequence of media data; and

 in a second pass, encoding the sequence of media data, wherein the peak bitrate constraint affects quality and bitrate in the second pass if the peak bitrate constraint is enabled for the sequence.

62. The method of claim 61 wherein the media data are audio data.

63. The method of claim 61 wherein the media encoder models a decoder buffer to test the peak bitrate constraint.

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64. The method of claim 63 wherein the media encoder adjusts one or more control parameters to avoid underflow in the decoder buffer.

65. A computer-readable medium storing computer-executable instructions for 10 causing the media encoder to perform the method of claim 61.

66. In a media encoder, a computer-implemented method of media encoding, the method comprising:

15 in a first pass, encoding media data;
processing results of the encoding in the first pass, wherein the processing includes setting a checkpoint at a defined percentage of a target total bit count for the media data; and

in a second pass, encoding media data, wherein the encoding in the second pass includes checking results of the encoding in the second pass as of the checkpoint.

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67. The method of claim 66 wherein the media data are audio data.

68. The method of claim 66 wherein the encoding in the second pass further includes adjusting a target quality level based at least in part upon the results of the encoding in the second pass as of the checkpoint

5 69. The method of claim 66 further comprising, at the checkpoint, computing a subsequent checkpoint at a multiple of the defined percentage of the target total bit count, wherein the encoding in the second pass further includes checking results of the encoding in the second pass as of the subsequent checkpoint.

10 70. A computer-readable medium storing computer-executable instructions for causing the media encoder to perform the method of claim 66.

71. In a media encoder, a computer-implemented method of media encoding, the method comprising:

15 in a first pass, encoding a sequence of media data;
 setting a checkpoint for encoding in a second pass; and
 in the second pass, iteratively:
 encoding media data up to the checkpoint,
 checking results of encoding in the second pass up to the checkpoint, and
20 updating the checkpoint for the encoding in the second pass, wherein the second pass continues until the sequence of media data is encoded.

72. The method of claim 71 wherein the media data are audio data.

73. The method of claim 71 further comprising:

- in the second pass, after the checking, adjusting one or more control parameters
- 5 if necessary based upon the results of encoding in the second pass up to the checkpoint, thereby improving uniformity of quality for the sequence.

74. The method of claim 73 wherein a first control parameter of the one or more control parameters is a target quality level.

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75. The method of claim 71 wherein the checkpoint is set and updated at multiples of a percentage of a target total bit count for the sequence.

76. A computer-readable medium storing computer-executable instructions for
15 causing the media encoder to perform the method of claim 71.

77. In an audio encoder, a computer-implemented method of audio encoding according to a multi-pass variable bitrate control strategy, the method comprising:

- in a first pass, encoding a sequence of audio data, wherein the sequence includes
- 20 plural chunks; and
- in a second pass, encoding the sequence of audio data in view of a goal of uniform quality at variable bitrate, wherein the encoding in the second pass includes

checking results at each of plural checkpoints, and wherein each of the plural checkpoints is separated from other checkpoints by at least two chunks.

78. The method of claim 77 wherein the checkpoints are set at defined points of
5 progression towards a target total bit count for the sequence.

79. The method of claim 77 further comprising adjusting the checkpoints during
the second pass.

10 80. The method of claim 77 further comprising adjusting a target quality at one
or more of the plural checkpoints to improve uniformity of quality in the sequence.

81. A computer-readable medium storing computer-executable instructions for
causing the media encoder to perform the method of claim 77.